VIBRATOR

CROSS REFERENCE TO PROVISIONAL APPLICATION

[0001] This application claims priority of U.S. Provisional Application No. 60/271,399. The whole content, including drawings, of that provisional application is incorporated by reference.

BACKGROUND OF INVENTION

[0002] In the construction industry, it is frequently necessary to lay a large area of concrete. Such areas can include, for example, foundations for buildings, floors, driveways, sidewalks, ramps, etc. Concrete exhibits characteristics of strength in compression but is poor in tension. To increase strength in tension, it is common practice to prepare a grid of reinforcing bars and then to pour concrete over and around the grid whereby the reinforcing bars improve the strength of the poured concrete.

[0003] Although the quality of the concrete improves with the dryness of the mix, it is nevertheless axiomatic that pourable concrete is wet in nature. Concrete is a mixture of cement, sand and stones. Lime is an ingredient in cement and water is added to the mixture to form a mix or slurry. The water activates the lime and an insufficient amount of water will not activate the lime. Consequently, the reinforcing bars in the grid are surrounded with a wet product and, if unprotected, the bars will rust. While moisture alone will create an environment which is conducive to rust, the problem is exacerbated in situations where water becomes contaminated with salt(s). Such conditions can occur, for example, when roads are spread with salt in wintertime or when the concrete is poured in an oceanfront community.

[0004] When a steel bar rusts it expands, and it will be appreciated that expansion of the bar within the concrete will cause the set concrete to crack.

[0005] To overcome this problem, it has been practice in the art to envelop the reinforcing bars in a plastic-like coating, most commonly an epoxy, which will protect the bar from wet liquid and hence avoid rusting and the subsequent detrimental consequences thereof.

[0006] After the wet concrete has been poured over and around the grid of reinforcing bars, it is common practice in the art to vibrate the concrete to remove air and voids from the poured mix. In this manner, when the concrete hardens, the slab will be more compact and undesirable pockets within the hardened concrete are avoided and the integrity of the concrete is not compromised.

[0007] Concrete vibrators take the form of a metal cylinder with a rotator inside which causes the metal cylinder to vibrate. The rotator is mounted on one end of a flexible drive cable and the vibrating cylinder is introduced into, and immersed in, the wet concrete mix and generates vibrations therewithin. Such vibrations may be of

a frequency of 10,000 vibrations per minute and an immediate problem arises in that such a rapidly vibrating metal cylinder will chip the plastic covering of the reinforcing bars, thereby exposing the metallic bars to the wet concrete and creating the potential for the destructive rust condition as described above.

[0008] To minimize this problem, advanced vibrator heads have been provided in which the metal cylinder is encased within a sleeve or sheath of robust but softer material. Such sheathed vibrators are commonly referred to as "rubberheads". The advantage is immediately apparent in that, although the exterior of a rubberhead vibrates at the same frequency as the enclosed steel core, the relative "softness" of the sheath is less likely to chip the plastic coating of the reinforcing bars.

[0009] Although achieving the foregoing advantage of minimizing destruction as reinforcing bars, sheathed vibrators ("rubberheads") create a disadvantage in that the steel core of the vibrator gets hot when vibrating at operating frequencies. With an unsheathed metal vibrator ("steelhead") the heat generated can easily be dissipated in the wet concrete slurry. However, when the steel core is sheathed in the manner of a rubberhead, it is necessary to make provision for conducting heat away during operation. For this purpose, it is known to provide apertures or openings in the surrounding sheath which expose the inner metallic core and enable the wet concrete slurry to contact the core and conduct away the heat. If no such apertures or openings are provided, then a rubber coating completely encompassing and concealing the vibrating metallic core would serve as an insulating surface and would retain heat.

[00010] U.S. Patent 5,556,199, owned by the applicant of this application, describes a rubberhead and the entire content of that earlier patent is incorporated herein by reference.

[00011] The present invention realizes that such apertures or openings passing through the sheath additionally function as suction cups in a rapidly vibrating vibrator and thereby hold wet concrete tight against the vibrating metallic core. The retention of concrete within the pockets by means of suction will cause the concrete to vibrate and thereby enhance the removal of air and elimination of pockets.

[00012] Although the suction cup effect of the apertures enhances vibration, the present invention greatly increases vibration by configuring the sheath to amplify the shockwaves transmitted into the wet concrete by the vibrating vibrator.

[00013] In prior vibrators, the cooling apertures or pockets in the sheath have been either straight-sided or flared outwardly from the surface of the metallic core to the outer surface of the sheath. With each of these configurations of the cooling apertures the apertures open into a relatively smooth surface portion of the sheath.

SUMMARY OF INVENTION

[00014] One embodiment of a vibrator of the present invention is cylindrical with a conical leading end and a tapered rearward end. A cylindrical steel core housing a vibrating mechanism is surrounded by a sheath of material which is softer than the metallic core. A plurality of apertures extend through the shaft to expose portions of the metallic core. The apertures are elongated and groups of apertures are disposed around the periphery of the sheath with the elongated apertures in each group having their longitudinal axes aligned with the longitudinal axis of the vibrator.

[00015] In order to increase the shockwaves imparted by the vibrating vibrator, the present invention configures the external sheath so that there are upstanding wall portions, at least around the apertures, which serve to "drive" the shockwaves into the concrete surrounding the vibrator.

[00016] In order to provide an upstanding wall portion at the location of each cooling aperture, the configuration of the sheath is such that the leading side (in the direction of oscillation) of each elongated aperture is cut away in such manner that the cut away portion reduces the height of said leading side of the aperture. The cut away portion may lead directly to the steel core or there may be a step down from the level at which the cut away portion enters the aperture down to the steel core. With this configuration, the opposite or trailing side of the aperture is exposed and presents an upstanding wall portion which serves to "drive" shockwaves into the concrete.

[00017] In addition to exposing the trailing side of the apertures in the manner described in the preceding paragraph, longitudinal recesses may be provided in the surface of the sleeve similarly to present an upstanding wall portions facing the direction of vibration.

DESCRIPTION OF THE DRAWINGS

[00018] The invention will now be more particularly described with reference to the accompanying drawings in which:

[00019] Figure 1 is a perspective view of a first embodiment of a vibrator head of the invention;

[00020] Figure 2 is a side elevation of the embodiment to Figure 1;

[00021] Figure 3 is a section along the line III-III of Figure 1;

[00022] Figure 4 is a perspective view of a second embodiment of the invention;

[00023] Figure 5 is a side elevation of the embodiment of Figure 4;

Sub A1 [00024] Figure 6 is a section along the line VI-VI of Figure 5;

Sub A2 [00025] Figure 7 is a section along the line VII-VII of Figure 5;

[00026] Figure 8 is a perspective view of a further embodiment of the invention;

[00027] Figure 9 is a perspective view of a still further embodiment of the

invention;

[00028] Figure 10 is an elevation of the embodiment shown in Figure 9;

Sub A3 [00029] Figure 11 is a section along the line XI-XI of Figure 10;

Sub A4 [00030] Figure 12 is a section along the line XII-XII of Figure 10;

Sub [00031] Figure 13 is a perspective view of a further embodiment of the invention;

[00032] Figure 14 is a side elevation of the embodiment shown in Figure 13;

Sub A5 [00033] Figure 15 is a section along the line XV-XV of Figure 14;

Sub A6 [00034] Figure 16 is a section along the line XVI-XVI of Figure 14;

Sub [00035] Figure 17 is a perspective view of a further embodiment of the invention;

[00036] Figure 18 is a side elevation view of the embodiment of Figure 17;

Sub A7 [00037] Figure 19 is a section along the line XIX-XIX of Figure 18; and

Sub A8 [00038] Figure 20 is a section along the line XX-XX of Figure 18.

[00039] Before describing preferred embodiments of the invention with reference to the drawings, it is again observed that this application claims priority from Provisional Application 60/271,399. That provisional application included twenty eight figures of drawings all of which are incorporated herein by reference.

DESCRIPTION OF PREFERRED EMBODIMENTS

[00040] Figure 1 of the drawings shows a first embodiment of a vibrator of the invention. As explained, the vibrator includes a metal cylinder 1 through which a concentric shaft 2 extends. An eccentric weight 3 is secured on the shaft for rotation thereby. Rotation of the shaft 2 with the concentric weight 3 causes the cylinder to vibrate. The shaft 2 is coupled to external drive source by a cable not shown in Figure 1 but schematically designated by reference numeral 4 in Figure 2 and 4′ in Figure 4 of the drawings. The cable 4,4′ is coupled to the shaft 2 by conventional means and the eccentric weight 3 may be welded to or keyed on the shaft 2, again in accordance with conventional practice.

[00041] The metal cylinder 1 is completely surrounded by a sheath 5 of robust, but relatively soft material. The sheath is rubber-like in consistency and hence gives name to the term “rubberhead”.

[00042] As explained in the opening paragraphs of the specification, vibration of the metal cylinder by rotation of the eccentric weight mounted on the shaft generates a substantial amount of heat and, in order to dissipate this heat, apertures 6 extend through the sheath 5 to expose portions of the underlying cylinder 1. In this manner, when the vibrator head is immersed in a wet slurry, wet slurry will contact the cylinder through the apertures and assert a cooling effect.

[00043] In use, the rapidly vibrating head agitates slurry to remove pockets and voids and enhance setting of the poured concrete. Agitation is effectively increased by transmitting shockwaves into the wet concrete mix from the vibrator. To this end, the external surface of the sheath 5 is configured to drive shockwaves into wet concrete by the vibrating vibrator.

[00044] Referring specifically to the embodiment shown in Figures 1 to 3 of the drawings, the sheath 5 extends around and encompasses the cylinder 1. Elongated recesses 7 are cut into the sheath external surface with the bottoms 8 of the recesses 7 lying on chord planes around the external surface of the sheath. In this manner, each recess bottom 8 terminates at the foot of an upstanding wall portion 9, with each wall portion extending longitudinally at least part way along the length of the sheath. These upstanding wall portions will serve to "drive" shockwaves outwardly of the sheath when the latter is vibrated by the shaft and eccentric weight. Similar upstanding wall portions extend along one longitudinal edge of the apertures 6 in the manner now to be described.

[00045] Still referring to Figures 1 to 3 of the drawings, each aperture 6 is an elongated slot extending from the external surface of the sheath through to the metal cylinder to expose a portion of that cylinder. Each aperture 6 opens into the bottom of an elongated recess and with the vibrator head vibrating in an anti-clockwise orbital motion, each aperture can be said to have leading side edge 10 and a trailing side edge 11. The trailing side edge 11 extends upwardly, substantially perpendicularly, from the aperture bottom to the bottom 8 of the elongated recess 7. The leading edge 10 is cut away, again in the plane of a chord, to open into the sheath surface at a region intermediate into elongated recesses. A plurality of apertures 6 are provided in each recess 7 and, in the embodiment shown in Figures 1 to 3, some recesses accommodate three apertures while other recesses accommodate two apertures. The regions intermediate the recesses 7 are lands designed by reference numeral 12 in Figure 1 of the drawings. In this manner, as viewed along a chord plane, the cut away leading edges of the recesses expose the trailing edges which, like the wall portions 9 of the elongated recesses 7, stand proud and serve to enhance the transmission of shockwaves into the wet concrete slurry surrounding the vibrator head in use.

[00046] As shown most clearly in Figures 1 and 2, the vibrator head is of overall cylindrical appearance with tapered leading and trailing end portions. The leading end portion 13 is frusto-conical in shape and the trailing end portion 14 is similarly configured and receives the cable 4 which serves to vibrate the shaft 2.

[00047] Plurality of tear-shaped recesses 15,16 are provided respectively in the leading and trailing end portions 13,14. Each tear-shaped recess has a floor 17 which,

similarly to the recesses 7, lies on a chord plane and the leading edge in the direction of oscillatory vibration opens smoothly into the surface of the frusto-conical end portion. With this configuration, the trailing edge of the tear-shaped recess provides an upstanding wall portion 18,19 which compliments the upstanding wall portions 9,11 of the elongated recesses 7 and apertures 6 further to enhance the driving of shockwaves into the concrete slurry in use.

[00048] In the embodiment shown in Figures 4 to 7 of the drawings, a vibrator head is similarly generally cylindrical in form with tapered frusto-conical leading and trailing end portions 33,34. Elongated recesses 27 extend longitudinally part way along the cylindrical portion and apertures 26 are formed wholly within those recesses. Thus, unlike the embodiment of Figures 1 to 3, the leading side edges 30 of the apertures 26 do not extend into the regions 32 between the recesses 27 and hence the apertures 6 present less prominent trailing side edges 31. Moreover, only the leading end portion 33 has tear-shaped recesses 35 with floor portions 37 which merge smoothly into the surface of the frusto-conical leading end portion to present prominently upstanding wall portions 38 to enhance driving shockwaves. The corresponding portions on the trailing end portion are generally plane in configuration.

[00049] Further alternative arrangements are shown in the embodiments of Figures 8 and 9. In the embodiment of Figure 8, tear-shaped recesses 46 presenting upstanding wall portions 49 are provided in the trailing end portion 44 whereas generally plane portions are provided in the leading end portion 43. In the embodiment of Figure 9 upstanding wall portions 58,59 are provided in tear-shaped recesses 55,56 in the respective leading and trailing edges 53 and 54. In both the Figure 8 and Figure 9 embodiments the apertures 46,56 are wholly within the elongated recesses 47 and 57.

[00050] Turning now to the embodiment of Figures 13 to 16, this embodiment is similar to the embodiment described with reference to Figures 1 to 3 with the exception that tear-shaped recesses 65 are provided in the leading end portion 63 to present upstanding wall portions 68 whereas generally plane portions are provided in the trailing end portion 64. In this embodiment the leading side edges 60 of the apertures 66 are cut away to merge with the regions 62 between elongated recesses 67 to present prominently upstanding trailing side edges 61 of which, together with the upstanding wall portions 68 of the leading end portion 63 serve to drive shockwaves into the concrete in use. The opposite arrangement is shown in the embodiment of Figures 17 to 20 where tear-shaped recesses 76 are provided in the frusto-conical trailing end portion 74 to present upstanding shockwave driving wall portions 79 whereas generally plane portions are provided on the frusto-conical leading end

portion 73.

[00051] In all the foregoing described embodiments, at least some portions of the sheath are configured to provide upstanding wall portions which face in the direction of oscillatory vibration in use and serve to drive agitating shockwaves in the concrete. It will be appreciated that other combinations of apertures/longitudinal recesses, leading and trailing end portions can be provided but all with the object of providing enhanced shockwave transmission.